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TREATMENT OF SURGICAL SHOCK  
IN WAR INJURIES

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It is recognized that surgical shock is greatly influenced in degree by individual susceptibility, by location of injury, by sex, age, and by previous disease or condition of the wounded. It may well happen, therefore, that soldiers exhausted by anxiety, fatigue, loss of sleep, and horror at their personal disfigurement, may show grave shock after severe facial mutilation. The mental depression will doubtless aid in the establishment of the lowered vital energy which causes the prostration, pallor of surface, clammy sweating, shrunken countenance, low temperature, feeble, frequent pulse, shallow breathing and the languid response to questions. Longmore, Weir Mitchell, Howell, Henderson, Crile, Meltzer, Porter and other physiologists and surgeons have given much attention to the pathology of surgical shock. It is probable that the term "shock" should be abandoned, because several pathologic entities with similar terminal symptom complexes have been included in the term.

In a clinical contribution to the subject written years ago I collected some data from experimental literature showing that "delayed" shock

\* Read at the General Meeting of the Medical Society of the State of Pennsylvania, Philadelphia Session, Sept. 24, 1918.

was a misnomer and that fat embolism had as one of its points of difference from true surgical shock its later arrival in the patient's symptomatology.<sup>1</sup>

More important in war surgery than discussion of the physiologic nature of shock are the questions of prevention and treatment. Avoidance of a fall in blood pressure, prevention of pain, and control in severity of traumatism are to be insisted on as prophylactic measures. Blood pressure must be maintained; hence, hemostasis is paramount. Anesthesia should not be allowed to reduce blood pressure, nor should it be toxic to a dangerous degree. Ether, although the safe anesthetic for general use, is not always given in a manner to fulfil both these conditions. It is toxic to nerve tissue and glandular organs and reduces blood pressure also. Janeway and Ewing assert that, unless administered with great care, it strongly reduces blood pressure. Nitrous oxid is safer in both directions and with associated nerve blocking may, perhaps, finally surpass ether in general availability.

Porter's observations in the European War prove to his satisfaction that low blood pressure is much more common in wounded soldiers than generally is believed by military surgeons. He states that fatalities may be greatly lessened by efficient treatment; and he bases his therapeutic methods on the similarity of results in laboratory work and his experience with wounded men at the front. He has found that

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1. See Packard's American Edition of Holmes' System of Surgery (1881), Vol. 1, p. 143.

a diastolic blood pressure of 45 to 50 mm. continued for a considerable time means that a laboratory animal will die of shock, unless saved by surgical treatment. The experimental animal, it is asserted by some, bleeds to death into its own portal veins, whenever accumulation of blood in the abdomen reduces the diastolic blood pressure to or below the critical point of 50 mm., unless prompt remedies are provided.

His assertion is that there is no essential difference between men and other animals in this low blood pressure criterion; hence, remedies that are successful in raising the blood pressure of one are to be adopted by surgeons for the relief of shock in the other. The wounded soldier, therefore, should have his blood pressure raised above the danger point by the aid of gravity, intravenous injection of sterile normal saline solution, and the employ of adrenalin. The supine position with the feet 30 cm. higher than the head should be maintained until diastolic pressure will remain close to the normal level. An hour or more may be needed to produce this effect in moderate shock. In grave emergency, the diastolic pressure should be raised promptly to 70 or 80 mm. by injection of normal salt solution into the venous current. The adoption of the hydrostatic saline injection should not be delayed; but the current flowing into the vein should be slow and continued until a pressure of 80 mm. has been reached. When the pressure falls again adrenalin should be given intravenously, preferably into a vein near the ankle. The test of sufficient venous medication is that the action of gravity has become able to maintain a safe blood pressure level.



The surgeon must remember that in very low pressure accompanied with persistent oozing of blood, and in which operation cannot be considered as an immediate remedial procedure, large injections of saline and adrenalin solutions may increase hemorrhage, by raising the general blood pressure. Transfusion of blood should then take the place of saline phlebotomy. This operation may carry the patient over the crisis and enable the surgeon to apply hemostatic pressure or ligatures to the bleeding points. The newer methods of transfusion with paraffined tubes and the use of sodium citrate render transfusion more available than was formerly the case. The blood may be kept in cold storage ready for immediate use.

Porter says that gravity is a most important agency in the treatment of shock. His words seem to indicate that he considers death inevitable in serious cases of perforation of the thorax which prevents the low chest posture, because it leads to asphyxia. In addition to the remedies already discussed external heat is of highest importance. Surgeons have long been familiar with the employment of heat. A hot bath might be employed while gravity and saline solutions are being used, provided its administration did not disturb the patients by the necessary movements. The wounded in shock must be kept hot, quiet, and have blood pressure raised to about 80 mm. Autotransfusion by bandaging the extremities may have value in increasing the general blood pressure. Prevention of escape of blood from oozing points by

applying firmly a broad elastic bandage directly over the pulped tissues, has value in military, railroad, and machinery amputations and crushes. It should take the place of the not unusual rubber tourniquet applied near the trunk by many thoughtless attendants. Taking the diastolic blood pressure as frequently as every half hour is almost imperative in serious shock. Its information surpasses in value that obtained from frequent temperature investigations.

Porter has devised a cheap and easily made operating table for the ready application of the foregoing principles of treatment for surgical shock with low blood pressure.<sup>2</sup>

The table is heated with electricity under the supine patient, whose feet may be readily raised 30 cm. higher than the head. This insures that the abdomen is higher than the heart and brain. The wounded man is kept in the inclined position an hour or two or even more; and the diastolic blood pressure raised promptly to 20 or 30 mm. above the critical point previously mentioned. If normal saline is being employed as an intravenous remedy, it should be discontinued when the diastolic pressure reaches 80 mm. If there occur a secondary drop of importance in the blood pressure, which is not improved by a second phlebotomy, intravenous injection of saline solution with adrenalin is advocated. Porter uses this remedy by means of a venous puncture near the ankle. He desires to raise and keep up blood pressure until gravity maintains a safe level.

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2. Boston Medical and Surgical Jour., Dec. 14, 1916, p. 857.

The temperature of solutions used should be 38° C. when sent into the venous channels, and about 500 c.c. is usually as much as is desirable at one time. A slow entrance of the solution lasts about ten minutes. The third injection should be the one to contain adrenalin and should slowly flow into the vein for about ten minutes. When diastolic pressure reaches 80 mm., the flow is discontinued. Fischel has objected to the use of adrenalin and pituitrin in shock unaccompanied by hemorrhage, and advises in such cases vasodilators instead of vasoconstrictors with the customary application of heat.

The surgeon should not overlook the value of the alkaloids found in opium and belladonna in treating shocked patients. Both have seemed to be clinically serviceable in some forms of the grave depression usually included in the term surgical shock. Obtunding pain, relieving fright and anxiety and inducing rest in sleep by morphin have surely some therapeutic virtue. Atropin also has had many advocates, perhaps used as a companion of morphin, its physiologic antagonist. The forced inhalation of carbonic acid gas has seemed applicable to the cases studied by Porter in the War Zone.

Surgical shock must be differentiated from the much discussed "shell shock" of recent literature. This symptom complex, so frequent in the trenches of France at this time, probably has been caused by deep exhaustion of mind and body from continued fatigue, and hysterical conditions in the psychologically infirm individual; and has been applied to various neu-

roses of traumatic origin. It is said that prisoners, who have been delivered by capture from the strain of trench life, and badly wounded men do not show "shell-shock."

#### SHOCK AND ANESTHESIA

C. L. Gibson says the wounded man at the advanced dressing station (British) "receives sufficient anodyne to make his journey to the next station (Casualty Clearing Station) comfortable, and it has been found that the generous use of anodynes prior to operation has a marked effect in diminishing shock."<sup>3</sup> There is less shock if compound fractures of thigh are thoroughly immobilized during transportation.

Anesthesia with ether should be preceded by fair doses of morphin. Five per cent. solution of picric acid may be painted on field of operation after cleansing with soft soap and water. This is cheaper and less irritating than tincture of iodin. Wounds of entrance and exit should be excised, laying open track of projectile and cutting away damaged and infiltrated tissue and wound washed out with anti-septic, often ether. Excision should be much as in cancer to get rid of damaged tissues and those into which blood has infiltrated.

Geoffrey Marshall<sup>4</sup> says that intrathecal administration of stovain is dangerous when used as an anesthetic for the recently wounded. In many cases its use is followed by a great fall of blood pressure and symptoms of cerebral anemia, such as pallor, vomiting, loss of conscious-

3. Scribner's Magazine for May, 1918, p. 598.

4. See British Surgery at the Front, p. 48.



ness and, perhaps, convulsions. The syncope is sometimes fatal. An analysis of fifty consecutive operations has shown in Marshall's opinion that it is the man who has lost blood and whose wounds are less than forty hours old to whom spinal anesthesia with stovain is dangerous. The patients had wounds of lower extremities, and the hemoglobin percentage was recorded before operation. The records seem to show that a low hemoglobin percentage is not followed by collapse after a late intraspinal anesthesia with stovain; but it is very apt to have such a formidable sequel when used early, say within forty hours of injury, should a low hemoglobin percentage show the blood diluted by hemorrhage.

Intrathecal stovain anesthesia produced a collapse in shocked patients which neither strychnin nor pituitrin were able to combat, nor did preliminary injection of strychnin prevent this collapse. The most satisfactory preventive was to have the head of the patient low and the feet high. This posture may be given the patient with safety, Marshall says, by waiting fifteen minutes after the stovain lumbar injection.

Marshall further states that a man suffering shock from a recently shattered limb which must be amputated, is a very unfavorable subject for general anesthesia. He advocates, for a reduction of mortality, rest in bed and hot bottles or a hot air bath. He says morphin should be given only in small doses or withheld.

Gas and oxygen are so much safer than any other anesthetic, in his opinion, that "no other is justifiable."



His statements are that with chloroform the man's condition will deteriorate and he will not rally; that with ether, by inhalation, the patient's condition may improve and blood pressure rise during operation, but collapse will occur within two hours. Intravenous use of ether may be followed by a more striking temporary improvement, but the subsequent collapse will be deeper and the fatal result more frequent.

Geoffrey Marshall speaks of shock in the wounded as a condition which evades exact definition. Its causes, he says, are almost invariably injuries which are severe from involving important structures or from having invaded extensive areas of tissue. The symptoms in a typical case are a dusky pallor of the face, flickering or imperceptible pulse, low surface temperature, and repeated vomiting, with little mental disturbance. The patient may be fully conscious and intelligent up to within a few minutes of death. The blood pressure, when taken in the brachial artery with a Riva-Rocci sphygmomanometer, is often higher than would be expected from the character of the pulse as determined by palpation of the radial artery at the wrist. When the shock symptoms are profound, the systolic pressure is usually below 80 mm. of mercury. The blood in the capillaries of the extremities is dark and of a cyanotic color. He has found in shock cases without hemorrhage blood more concentrated than normal.

Shock should be lessened by treatment before even urgent operations are attempted. External

warmth commonly produces definite improvement. It should be associated with rest in bed. Gradually the temperature rises, the color improves, and the arterial blood pressure goes up. I believe that time is an important element in obtaining this improvement.

According to Marshall, subcutaneous infusion of saline solution produces no measurable effect in this type of shock. This is shown by the fact that, if death occurs so late as thirty hours after such injections, most of the solution will be found still unabsorbed in the subcutaneous tissues. Even intravenous injection of normal saline solution given before operation is of little value. It may cause a temporary rise of blood pressure and slow the pulse rate, but it does not prevent the occurrence of further shock from the operative attack. The blood pressure falls at the moment operation is begun.

Transfusion of blood done towards the end of an operation is beneficial. Hypertonic saline is better than normal saline solution. These remedies thus given cause a more lasting elevation of blood pressure with slowing of the pulse. Marshall ventures no opinion as to the value of artificial viscosity given to the transfused solution.

That patients in serious depression from sepsis stand anesthesia and amputation better than those depressed by shock is the experience of Marshall. This is in accordance with the opinion of general surgeons. The septic cases, he thinks, do well under anesthesia from gas and oxygen; and that warm ether vapor by

inhalation or intravenous ether, are comparatively safe. Chloroform, he says, should be avoided, even in septic cases.

These deductions of Marshall may, perhaps, be drawn without sufficient recognition of the variation in the degree of shock which existed in cases studied by him.

#### LIMITATION OF SHOCK DURING OPERATION

It must be remembered that in warfare the evidences of shock in the wounded man may be greatly increased by exposure after injury or by fatigue, anxiety and want of food prior to battle. Cold, loss of blood, pain and mental depression, while lying on the field of combat exposed to the elements and to repetition of injury, and later the distress of transportation must deepen the depression of vital forces. Time is, therefore, an important factor in comparing cases of shock, whether one be studying the symptoms or the relative value of methods, of treatment.

Warmth and rest are more important than food; but the last in small quantities and easily assimilated has a bearing on the reaction from shock. Time is of supreme value in the opinion of many experienced surgeons.

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